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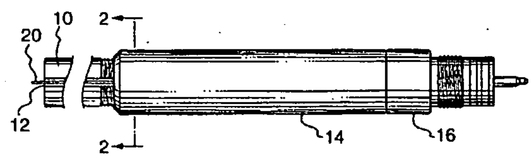
(54) AMELIORATIONS AUX OUTILS DE FOND DE TROU
(54) IMPROVEMENTS IN DOWNHOLE TOOLS

(57) The invention relates to a continuous rod system for downhole operations. In particular, the invention relates a continuous rod having a groove along the exterior of the rod which retains a data transmission wire within the groove. The rod construction in accordance with the invention simplifies the incorporation of a data transmission wire within a continuous rod.



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SECTION 8 CORRECTION
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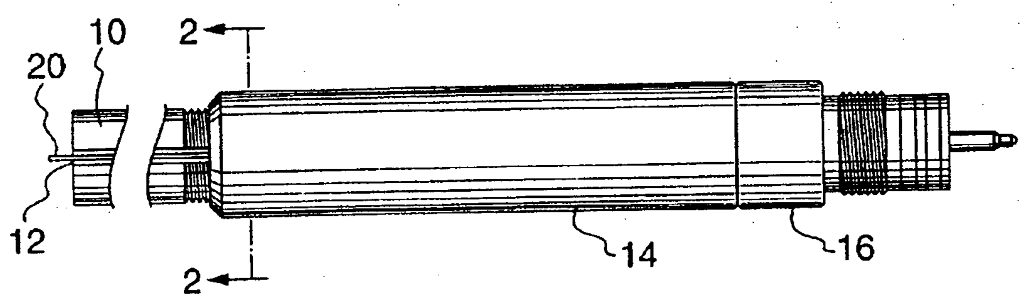
CORRECTION ARTICLE 8
VOIR CERTIFICAT

(54) Titre : AMELIORATIONS AUX OUTILS DE FOND DE TROU
(54) Title: IMPROVEMENTS IN DOWNHOLE TOOLS



(57) Abrégé/Abstract:
The invention relates to a continuous rod system for downhole operations. In particular, the invention relates a continuous rod having a groove along the exterior of the rod which retains a data transmission wire within the groove. The rod construction in accordance with the invention simplifies the incorporation of a data transmission wire within a continuous rod.

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Certificat de correction

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Certificate of Correction

Canadian Application No. 2,335,192
Filed: February 9, 2001

Les corrections suivantes sont faites en raison de l'article 8 de la *Loi sur les brevets* et le document doit être lu tel que corrigé.

The following corrections are made pursuant to section 8 of the *Patent Act* and the document should read as corrected.

In the Patent application:

1. The applicant has been amended to read:

COMPUTALOG LTD.

2. The assignee of Canadian registration number 5113684 has been amended to read:

COMPUTALOG LTD.

Agent certificateur / Certifying Officer

December 12, 2001

Date

ABSTRACT

The invention relates to a continuous rod system for downhole operations. In particular, the invention relates a continuous rod having a groove along the exterior of the rod which retains a data transmission wire within the groove. The rod construction in accordance with the invention simplifies the incorporation of a data transmission wire within a continuous rod.

Improvements in Downhole Tools

FIELD OF THE INVENTION

The invention relates to a continuous rod system for downhole operations. In particular, the invention relates a continuous rod having a groove along the exterior of the rod which retains a data transmission wire within the groove. The rod construction in accordance with the invention simplifies the incorporation of a data transmission wire within a continuous rod.

BACKGROUND OF THE INVENTION

It is well known in the petroleum industry that many different exploration and production operations can be conducted using coiled tubing as a means for conveying a variety of downhole devices including logging equipment through a well bore. Coiled tubing is typically a continuous length of tubing having a flexibility sufficient to allow its storage on and deployment from a large diameter reel but at the same time having a stiffness permitting long lengths of the tubing to be pushed through highly deviated or horizontal bore holes.

With particular reference to the use of coiled tubing with logging equipment, electrical cable for conveying data and control signals to and from logging equipment has been placed within the annulus of a hollow coiled tube. However, the installation of electrical cable into the annulus of a hollow tube has been problematic for a number of reasons. For example, past techniques of installing an electrical cable within a hollow tube have included techniques such as uncoiling the tube on a long, relatively flat stretch of road and pumping the electrical cable through the tube by hydraulic pressure using a seal attached to the electrical cable. This technique is disadvantaged or limited by not only requiring a long section of a relatively flat and low traffic volume road near the well bore but also as it is likely to damage the cable by the very high tension forces applied to the cable during installation to allow the cable to be dragged through a very long section of pipe.

An alternative approach has been to install the tubing in a vertical well and lower or pump the electrical cable through the tubing. This technique is advantaged over the above technique by utilizing gravity to apply at least part of the motive force for moving the cable but is disadvantaged by

requiring an unused well close to the site of interest which has the vertical depth sufficient to receive the entire length of coiled tubing. An alternate technique has been to use pressurized gas, such as nitrogen, to pump the wire through the tubing while it is coiled on the spool.

Each of the above techniques are further limited by the effects of frictional wear to the exterior of the electrical cable as the cable moves through the tubing over any imperfections in the interior surface walls of the tubing.

Past techniques of permanently installed electrical cable have used, for example, seamed piping for containing the electrical cable. However, seamed piping, in order to have the necessary seam strength must be of a larger diameter to accommodate the seam and will also require sophisticated manufacturing techniques to ensure that the covering of the electrical cable is not damaged during the manufacturing process. In particular, seamed piping requires that the electrical cable is properly centred within the annulus to avoid heat damage from any welding process.

The installation of a centrally located electrical cable in relatively short sections of hollow tubing which are subsequently joined by welding has also been performed in the past. However, problems inherent with this technique include protection of the cable from welding heat and the accurate alignment of the interior surfaces of the annulus so as to eliminate burred surfaces which may damage the electrical cable covering.

Still further, others have utilized alternative techniques of connecting a downhole logging tool with data collection equipment by conducting an electrical signal through the tubing structure. However, these technique have resulted in unacceptable signal:noise ratios.

Accordingly, there has been a need for a more cost effective way which overcomes the above problems and provides an effective logging wire conveyance system having improved structural integrity, full protection of the electrical cable and provides ease of manufacturing.

SUMMARY OF THE INVENTION

In accordance with the invention, there is provided a continuous rod for conveying a downhole tool through a well bore comprising a longitudinal groove along the exterior of the rod for receiving and retaining a data transmission wire within the groove.

In accordance with another embodiment, there is provided a method for manufacturing a continuous rod for the transmission of data along a rod comprising forming a groove along the exterior of the rod, the groove for receiving and retaining a data transmission wire within the groove.

In accordance with a further embodiment, there is provided a data acquisition system comprising:

a continuous rod on a rotating spool, the continuous rod having a groove retaining a data transmission wire;

a downhole tool operatively connected a lower end of the continuous rod and a lower end of the data transmission wire; and,

a data commutator operatively connected to an upper end of the data transmission wire for transferring data from the rotating spool to a non-rotating data collection system.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features of the invention will be more apparent from the following description in which reference is made to the appended drawings wherein:

Figure 1 is a side view of a continuous coiled rod in accordance with the invention and a connection sleeve for attaching a cablehead contact sub;

Figure 2 is a cross-sectional view taken along lines 2-2 of Figure 1;

Figure 3 is a cross-sectional view taken along lines 3-3 of Figure 3;

Figure 4 is a detailed view of a groove in accordance with one embodiment of the invention;

Figure 4A is a detailed view of a groove in accordance with another embodiment of the invention;

Figure 4B is a detailed view of a groove in accordance with a further embodiment of the invention;

Figure 4C is a detailed view of a groove in accordance with a still further embodiment of the invention;

Figure 4D is a detailed view of a groove in accordance with a still further embodiment of the invention;

Figure 5A is a perspective view of a continuous rod unit and slip ring in accordance with the invention;

Figure 5B is an enlarged perspective view of the slip ring system in accordance with a preferred embodiment of the invention; and,

Figure 5C is a cross-sectional view of the slip ring system in accordance with one embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

With reference to Figures 1-4, a length of continuous coiled rod 10 having an exterior groove 12 is described. As is known in the art, the continuous rod may be round, semi-elliptical or elliptical and manufactured with different grades of steels to provide different properties as may be required for particular applications. Figure 1 shows a lower end of the rod 10 with a sleeve 14 and contact sub 16 attached thereto. Figure 2 shows a cross-sectional view of the sleeve 14, rod 10 and the groove 12. Figure 3 shows a longitudinal cross-sectional view of the rod 12, sleeve 14 and contact sub 16 and Figures 4-4D show details of the groove in accordance with various embodiments of the invention.

With specific reference to Figures 2 and 4, the groove 12 is shown having a circular cross-section with an open channel 18 on the exterior of the rod 10. The width, X, of the open channel 18 is less than the width, Y, of the groove 12 within the rod 10. In a preferred embodiment as shown in Figure 4, the ratio of the open channel at X is approximately 50% that of the diameter of the groove Y.

Electrical cable 20 is placed within the groove 12 and secured within the groove 12. In one embodiment, the cable 20 is secured with a binder 22 which fills the groove 12 to the outer edge of the rod 10. The binder effectively seals the cable 20 within the groove and prevents the cable 20 from separating from the rod 10.

The geometry of the groove is important to secure the cable within the groove. Figures 2 and 4 show a groove having a circular cross-section and Figures 4A, 4B, 4C and 4D show other embodiments including a wedge, a slotted profile, a recessed circular profile and a barbed profile wherein the interior width of the groove at at least one location within the groove, is greater than the width of the groove at the exterior of the rod 10. It is also understood that other cross-sectional shapes can be employed as understood by those skilled in the art.

The binder 20 used to anchor the cable 20 within the rod 10 can be selected from a number of binders known to those skilled in the art. Preferably, the binder 20 will have characteristics suitable for its use in a downhole environment, including thermal expansion properties similar to those of the rod 10 as well as flexibility and abrasion resistance. Layering of different binders may be utilized.

The binder may be a thermoplastic or a resin-based binder as would be understood by those skilled in the art.

In another embodiment, the electrical cable 20 may be provided with a covering or insulation having a cross-sectional profile matching that of the groove 12. In these embodiments, the electrical cable may be pressed into the groove 12 and retained in place by the friction of the insulation within the groove. Specific groove profiles such as that shown in Figure 4D with a barbed profile will further enhance retention of the electrical cable 20 within the groove. A layer of binder may be utilized to further ensure bonding between the electrical cable insulation and the interior surface of the groove.

The rod in accordance with the invention may be a continuous rod or have been welded to form a continuous from a number of shorter sections of rod. The exterior groove 12 is formed in the rod either before or after the shorter sections of rod are connected together. It is, however, preferred that the groove is formed after shorter sections are connected together to minimize the problems associated with alignment of adjacent grooves on adjacent sections of pipe. Accordingly, after forming a continuous section of coiled rod, in one embodiment, the groove is milled into rod.

The groove can be milled by a stationary mill with a moving rod passing the milling machine between a let-out and take-up spool of rod. In addition, a spiral groove may be milled in the rod in order to help retain the cable within the groove.

Upon completion of the groove, the rod is oriented such that the groove is at the top of the rod and the electrical cable is placed within the groove. The binder is introduced into the groove and allowed to set. Alternatively, the electrical cable may be press-fit within the groove as described above.

At the lower end of the continuous rod, the rod is adapted for attachment to a contact sub 16. In one embodiment, the end of the rod is provided with threads for threaded attachment to the sleeve. Similarly, a contact sub 16 may be threaded to the sleeve.

With reference to Figures 5A, 5B and 5C the continuous rod 10 is further adapted to allow the transmission of data to and from the rod while the rod is being coiled or uncoiled from a spool 50. As

is known, continuous rod is either wound or unwound from a spool 50 as the rod is placed into or withdrawn from a well bore. Preferably, the spool 50 is a truck mounted cage 51 which rotates about a central axis 52 and supports coiled rod 10 within the cage 51.

The uphole, or free-end of the continuous rod is secured to the cage 51 and the cable 20 extends from the free-end through a commutator or slip ring system 54 to a data processing/control system (not shown). As shown in Figures 5A and 5B, the slip ring system 54 is fixed to the hub 56 of the spool 50 via a hub pin 56a which is telescopically received within the hub 56 and secured with a screw connector 56b. The slip ring system 54 includes a mounting bracket 58 and a rotating shaft 60 secured to the rotating hub 56 or mounting member 56a with appropriate fasteners 62. The axis of the rotating shaft 60 is preferably aligned with the rotation axis 52. A bushing 59 may be utilized to align the hub pin 56a within hub 56 as well as to provide clearance to cables suspended from the commutator system. The slip ring system 54 also includes a non-rotating ring 64 which telescopically receives the rotating shaft 60. The non-rotating ring 64 may optionally include an anchor system 66 for tethering the non-rotating ring 64 to a fixed object such as a stake 68 as shown in Figure 5A.

The rotating shaft 60 and non-rotating ring 64 include an appropriate electrical contact system with brushes 64a and contacts 60a as shown schematically in Figure 5C and as would understood by a worker skilled in the art. A connector 64b allows an external cable 20a to be attached to the commutator system 54.

The terms and expressions which have been employed in this specification are used as terms of description and not of limitation, and there is no intention in the use of such terms and expressions to exclude any equivalents of the features shown and described or portions thereof, but it is recognized that various modifications are possible within the scope of the claims.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A rod for conveying a downhole tool through a well bore comprising a longitudinal groove along the exterior of the rod for receiving and retaining a data transmission wire within the groove.

2. A rod as in claim 1 wherein the width of the groove at the exterior of the rod is less than the width of the groove within the rod.

3. A rod as in claim 1 wherein the data transmission wire is at least partially retained within the groove with a binder.

4. A rod as in claim 3 wherein the binder is a polymer having a coefficient of thermal expansion effectively similar to the coefficient of thermal expansion of the rod.

5. A rod as in claim 3 wherein the binder is a polymer having a flexibility effectively similar to the flexibility of the rod.

6. A rod as in claim 1 wherein the data transmission wire has an insulation profile similar to the cross-sectional profile of the groove.

7. A rod as in claim 1 wherein the insulation profile is adapted for press-fitting within the groove.

8. A rod as in claim 1 wherein the cross-sectional profile of the groove is any one of a circular profile, a wedge profile, a key slot profile, a recessed circular profile or a barbed profile.

9. A rod as in claim 1 further comprising a threaded sleeve adapted for threaded attachment to the rod and a downhole contact sub.

10. A method for manufacturing a rod for the transmission of data along a rod comprising forming a groove along the exterior of the rod, the groove for receiving and retaining a data transmission wire within the groove.

11. A method as in claim 10 wherein the groove has a width at the exterior less than a width within the rod.

12. A method as in claim 11 wherein the data transmission wire is solution cast within the groove with a binder.

13. A method as in claim 12 wherein the data transmission wire is press-fit within the groove.

14. A data acquisition system comprising:

a continuous rod on a rotating spool, the continuous rod having a groove retaining a data transmission wire;

a downhole tool operatively connected a lower end of the continuous rod and a lower end of the data transmission wire; and,

a data commutator operatively connected to an upper end of the data transmission wire for transferring data from the rotating spool to a non-rotating data collection system.

15. A data acquisition system as in claim 14 wherein the data commutator includes a rotating member electrically connected to a non-rotating member by a brush and contact system.

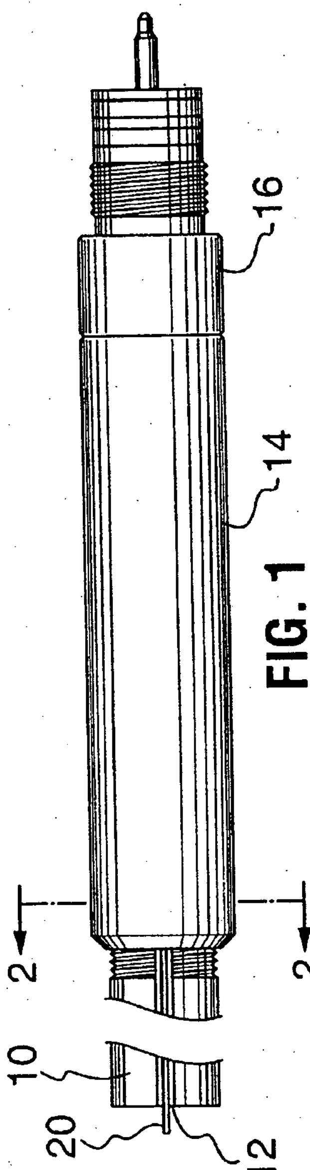

FIG. 1

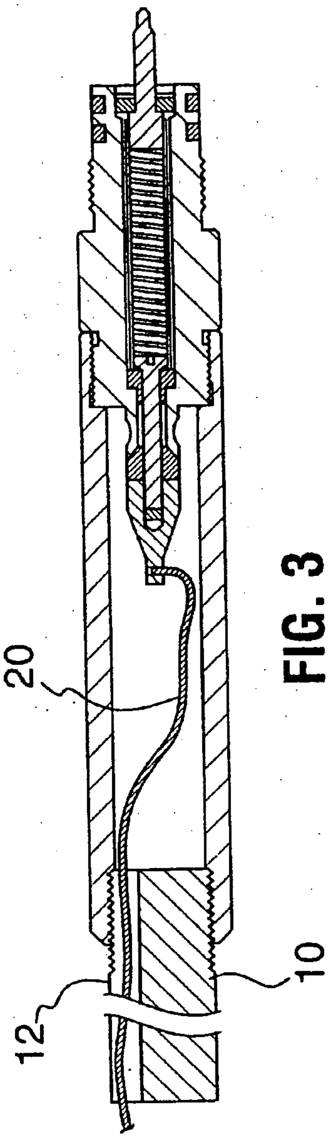

FIG. 3

FIG. 4D

FIG. 4C

FIG. 4B

FIG. 4A

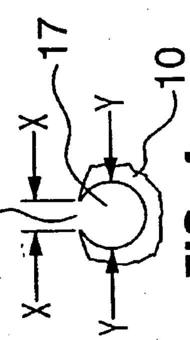

FIG. 4

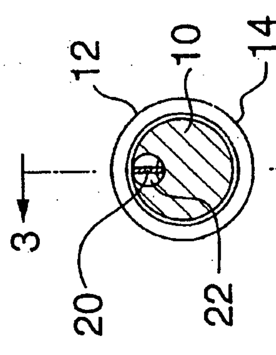

FIG. 2

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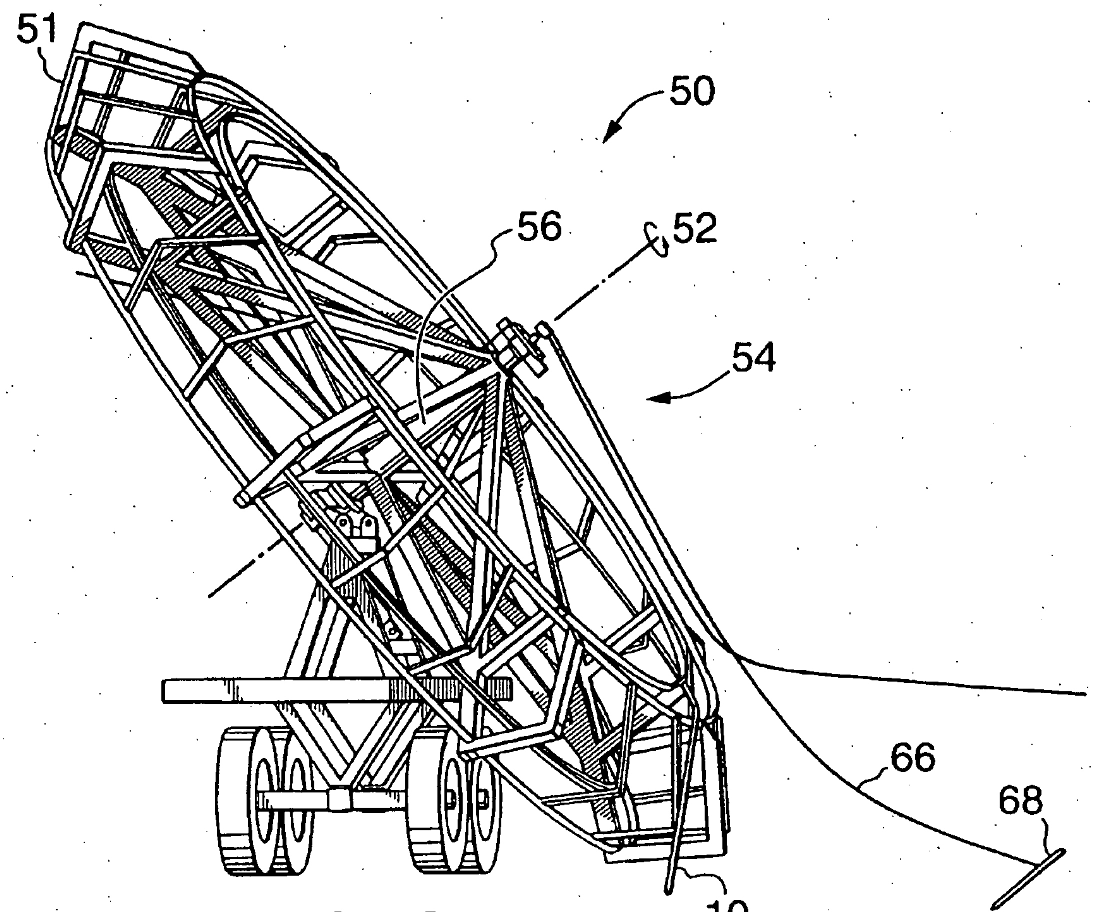

FIG. 5A

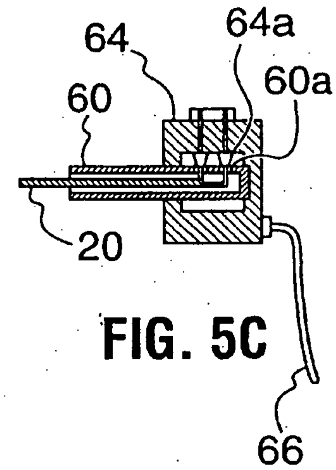

FIG. 5C

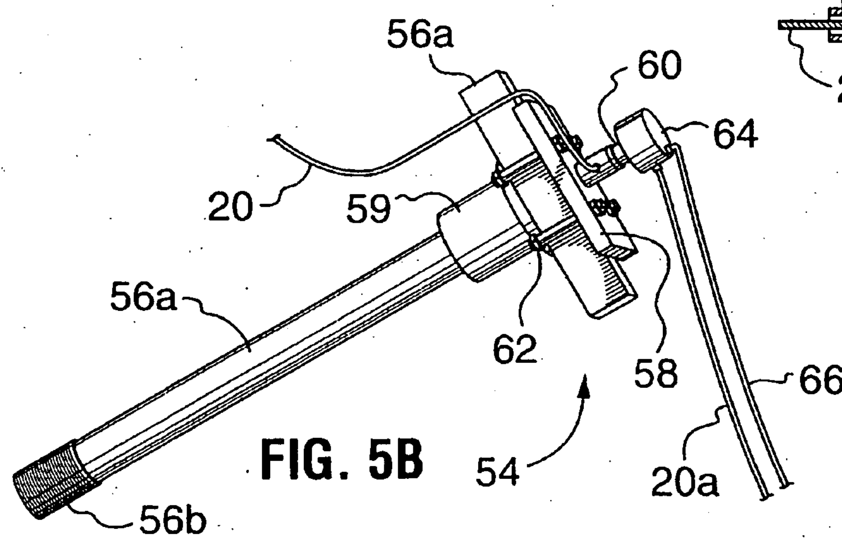

FIG. 5B

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